A.A.V. PATEL JR. COLLEGE
EXCELLENCE PROGRAM S.Y.J.C

SUB: PHYSICS SYNOPSIS

2 GRAVITATION H.S.C Weightage (3M)

1 GRAVITATION. GRAVITATION is the force of attraction between any two bodies.

2 GRAVITY - Gravity refers to the force of attraction between any body and the earth.

3 Newton's Law of Gravitation

Statement.

"Every particle of matter attracts every other particle of matter with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them."

$$F = \frac{G m_1 m_2}{r^2}$$

where -

G = universal gravitational constant

m_1 & m_2 = two masses

r = distance between two masses

S.I unit of G = 6.673×10^{-11} Nm^2/kg^2

S.I unit of G = Nm^2/kg^2

C.G.S unit of G = $dyne\ cm^2/g^2$

Dimensions of G = $[L^3 M^{-1} T^{-2}]$

4 Acceleration due to gravity 'g'.

$$g = \frac{GM}{R^2}$$

$$g_h = \frac{GM}{(R+h)^2}$$

5 Variation of 'g' due to Altitude

$$g_h = g\left[1 - \frac{2h}{R}\right]$$

where h = height from the surface of earth
R - Radius of the earth

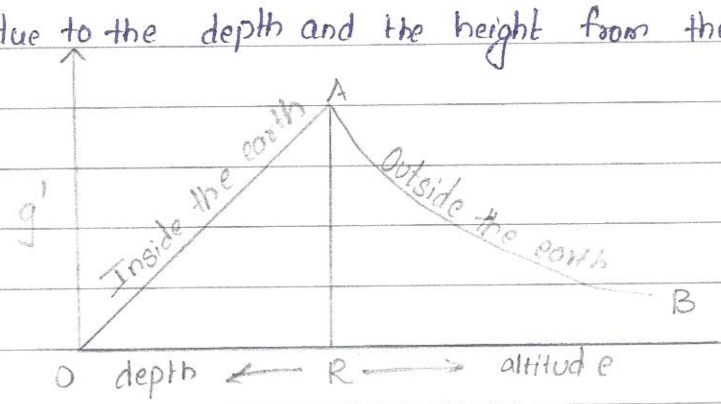
6. Variation of g due to depth

$$g_d = g\left[1 - \frac{d}{R}\right]$$

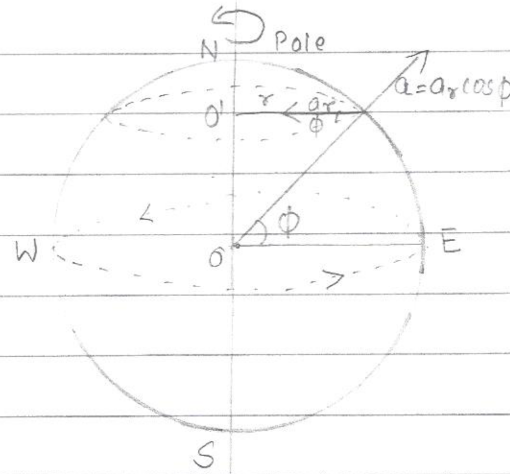
d = depth below the earth surface

NOTE :- At the centre of the earth $d = R$
$\therefore g_d = 0$.

7. Variation of g due to the depth and the height from the earth's surface



8. Variation of g due to latitude:



$$g' = g - R\omega^2 \cos^2\phi$$

Case 1) At equator $\phi = 0$

$\cos\phi = 1$

$g' = g - R\omega^2$

$g_E = g - R\omega^2$

Case 2) At poles $\phi = 90°$

$\cos\phi = 0$

$$g_P = g$$

9. Kepler's Laws of Motion.

Ist Law

I Kepler's First Law (Law of orbit)

Every planet revolves in an elliptical orbit round the sun, with the sun situated at one of the focii of the ellipse.

II Kepler's second Law (Law of equal areas)

The radius vector drawn from the sun to any planet sweeps out equal areas in equal intervals of time.

OR

The areal velocity of the radius vector is constant.

III Kepler's third law (Law of period)

The square of the period of revolution of the planet round the sun is directly proportional to the cube of the semi-major axis of the elliptical orbit.

$$T^2 \propto r^3$$

10 Critical velocity of a satellite

The minimum velocity that must be given to a satellite, so that it can revolve in a circular orbit round the earth is called critical velocity or orbital velocity.

$$V_c = \sqrt{\frac{GM}{R+h}}$$

V_c = critical velocity of satellite

11 Periodic Time of a Satellite

The time taken by the satellite to complete one revolution round the earth is called its period or periodic time (T).

$$T = 2\pi \sqrt{\frac{r^3}{GM}}$$

where $r = R + h$ where R = radius of the earth
h = height of the satellite above the earth surface

As $GM = g_h (R+h)^2$

$$\therefore \quad T = 2\pi \sqrt{\frac{(R+h)^3}{g_h (R+h)^2}}$$

$$T = 2\pi\sqrt{\frac{R+h}{g_h}}$$

$$T = 2\pi\sqrt{\frac{r}{g_h}}$$

For a satellite orbiting close to the surface of the earth (ie $R+h \approx R$ and $g_h = g$)

$$\therefore \ T = 2\pi\sqrt{\frac{R}{g}}$$

12 BINDING ENERGY

The minimum amount of energy required for satellite to escape from earth's gravitational influence is called as binding energy of a satellite.

Kinetic energy of the satellite $= \frac{1}{2}\frac{GMm}{r}$

Potential energy of the satellite $= -\frac{GMm}{r}$

Total energy of the satellite $= -\frac{1}{2}\frac{GMm}{r}$

Binding energy of the satellite $= +\frac{1}{2}\frac{GMm}{r}$.

13 Escape Velocity:

The minimum velocity with which a body should be projected from the surface of the earth, so that it escapes from the earth's ~~gravil~~ gravitational field, is called the escape velocity of the body.

$$V_e = \sqrt{\frac{2GM}{R}}$$

As $GM = gR^2$

$$V_e = \sqrt{2gR}$$